

# Roskill

## Bottlenecks in the lithium supply chain *Avoidable or inevitable?*

April 9<sup>th</sup> 2018

David Merriman



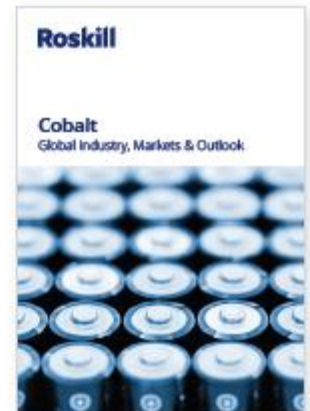
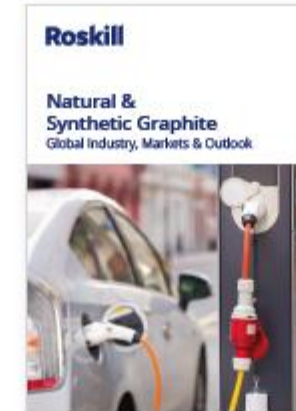
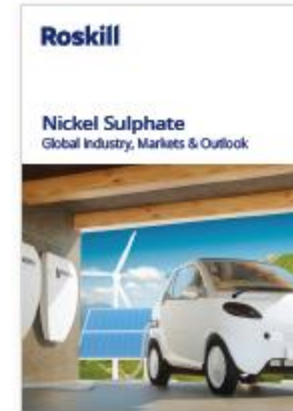
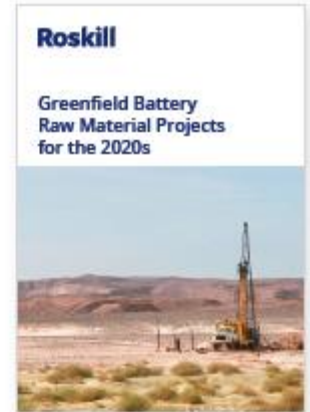
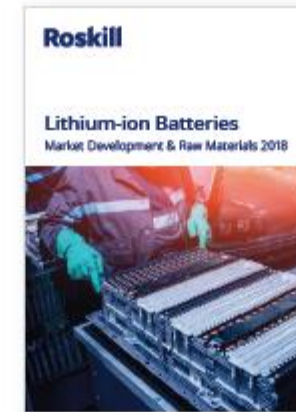
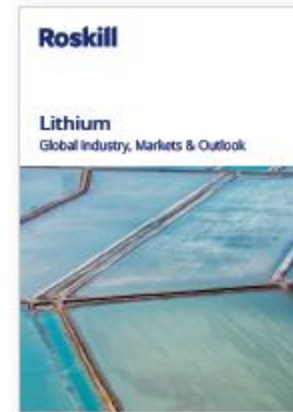
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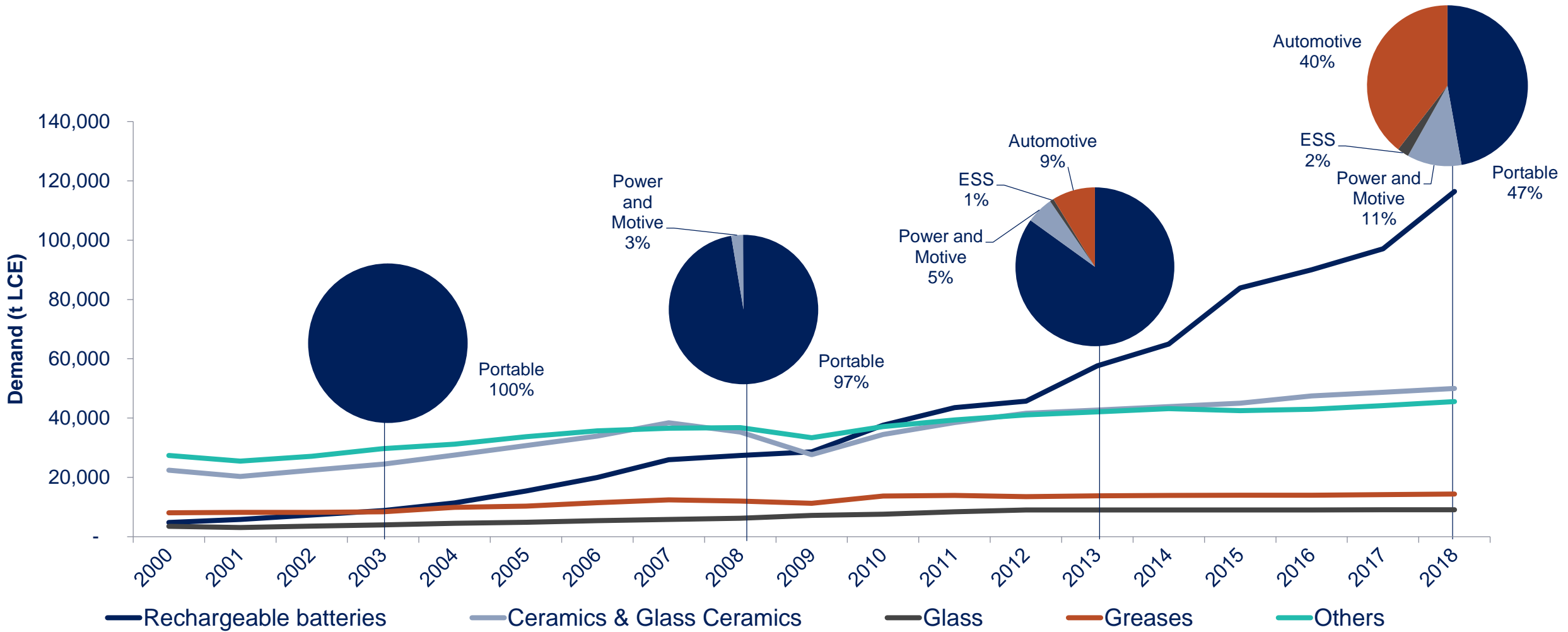
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# Introduction to Roskill:

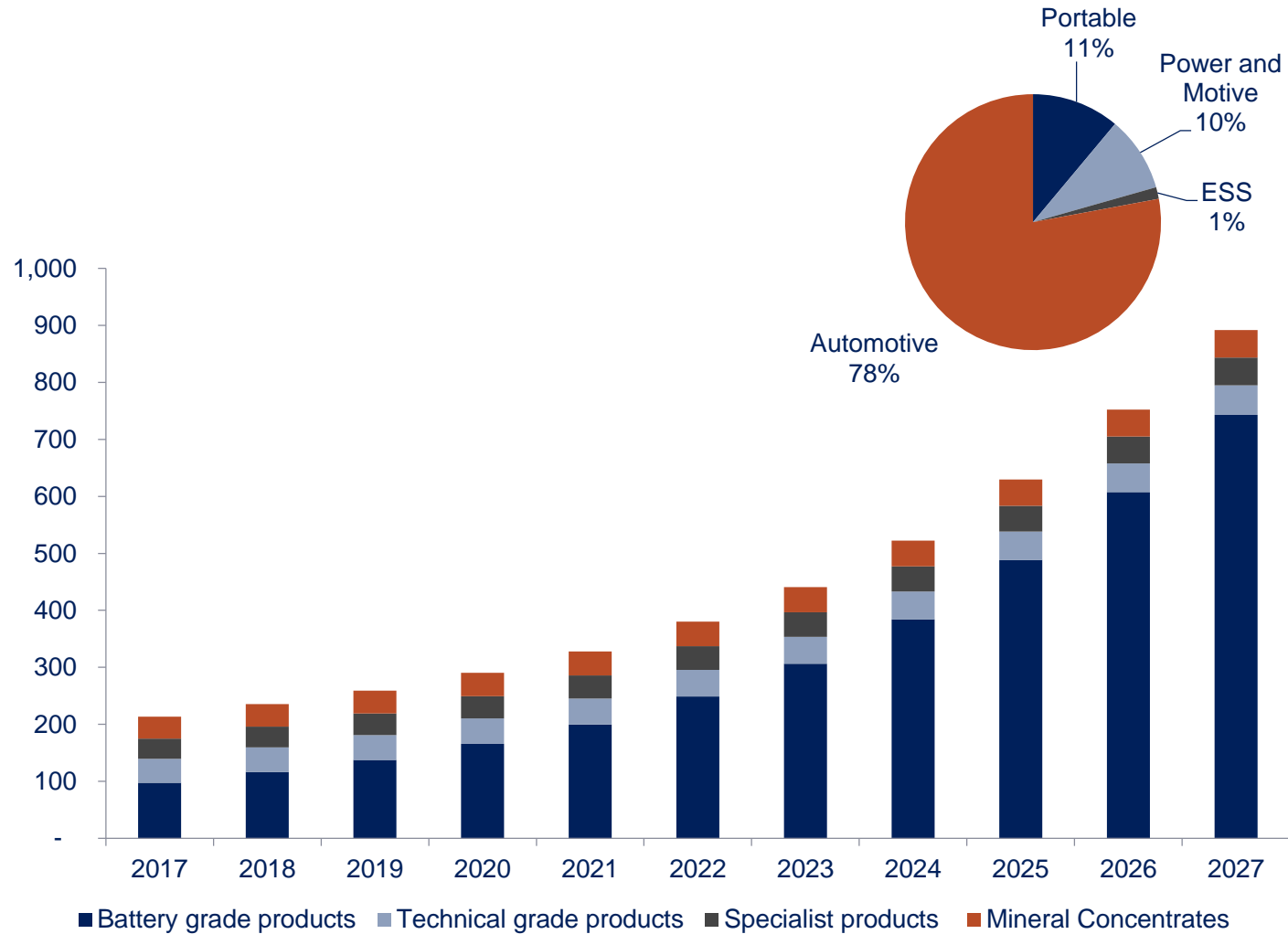
- Roskill is an independent consultancy focussed on steel alloys, battery and technology metals and industrial minerals research
- Roskill has a combination of research reports perfectly aligned to the EV and battery markets
- Commodity-focussed reports are sold on an annual subscription basis and include detailed ten-year outlooks on supply, demand and prices
- All reports utilise our extensive in-house battery model underpinned by our automotive, energy storage and consumer electronics forecasts



# Lithium demand has changed dramatically

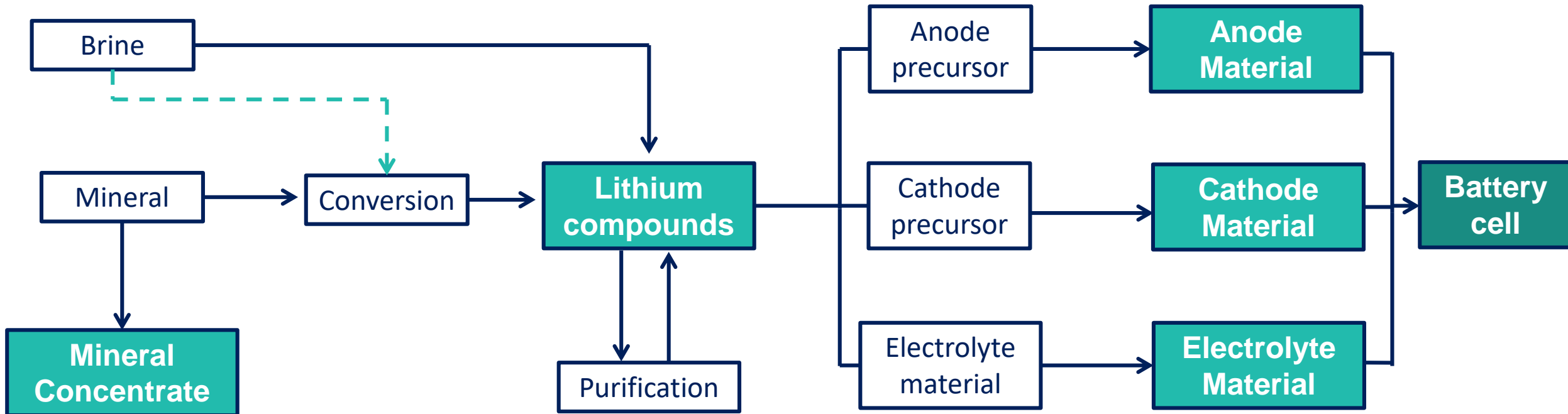


# Li-ion battery demand forecast increase its influence over lithium industry



- Lithium demand is forecast to increase by 15%py through to 2027
- Represents a 4.2x increase in total demand (~680kt LCE)
- Battery grade products (carbonate, hydroxide) formed 46% of demand in 2017
- Forecast to increase to >80% by 2027
- Automotive applications forecast to form 78% of battery demand by 2027

# Battery grade lithium products and battery components are complex to manufacture



Miners & Briners

Processors

Specialist Battery materials manufacturers

**Roskill**

# Mine supply and cell production have been well supported by investment



- Investment in the lithium supply chain has been focussed on mine supply and on the production of finished battery cells
- >1.5Mtpy LCE mine capacity under development (various stages) and >25 large scale battery facilities now in construction or development
- Investment in battery grade production and cathode manufacturer have received less attention, with expansions largely limited to existing producers

# Existing spod. converters with Australian/domestic feedstock are doubling their nameplate capacity

| Existing mineral conversion landscape |                        |                                       |                      |      |                                 |  |
|---------------------------------------|------------------------|---------------------------------------|----------------------|------|---------------------------------|--|
| Company                               | Plants                 | Nameplate capacity end-2017 (tpy LCE) | Expansions (tpy LCE) | Due  | Feedstock source                | Product  |
| Tianqi                                | Shehong                | 17,000                                | -                    | -    | Talison                         | Li <sub>2</sub> CO <sub>3</sub> / LiOH                             |
|                                       | Zhangjiagang           | 17,000                                | -                    | -    | Talison                         | Li <sub>2</sub> CO <sub>3</sub>                                    |
|                                       | Kwinana <sup>1</sup>   | -                                     | 42,400               | 2019 | Talison                         | LiOH   |
| Albemarle                             | Fenyi                  | 10,000                                | 20,000               | 2018 | Talison                         | Li <sub>2</sub> CO <sub>3</sub> / LiOH                             |
|                                       | Pengshan               | 5,000                                 | -                    | -    | Talison                         | Li <sub>2</sub> CO <sub>3</sub> / LiOH                             |
|                                       | Kwinana <sup>1,2</sup> | -                                     | 40,000               | 2021 | Talison                         | LiOH   |
| Ganfeng                               | Xinyu                  | 29,000                                | 17,600               | 2018 | PMI                             | Li <sub>2</sub> CO <sub>3</sub> / LiOH                             |
|                                       | Ganxian                | 2,000                                 | -                    | -    | Local                           | Li <sub>2</sub> CO <sub>3</sub>                                    |
|                                       | Ningdu                 | -                                     | 17,500               | 2018 | PMI                             | Li <sub>2</sub> CO <sub>3</sub>                                    |
| General Lithium                       | Haimen Jiangxi         | 8,000                                 | -                    | -    | Talison (toll), Galaxy, Pilbara | Li <sub>2</sub> CO <sub>3</sub><br>Li <sub>2</sub> CO <sub>3</sub> |
| Ruifu                                 | Feicheng               | 28,000                                | 10,000               | -    | Galaxy                          | Li <sub>2</sub> CO <sub>3</sub> / LiOH                             |
| Yahua                                 | Xuankou X2             | 8,000                                 | -                    | -    | Local, Galaxy                   | LiOH   |
|                                       | Meishan                | 3,000                                 | 9,400                | 2018 | Galaxy                          | LiOH   |
| Zhonghe                               | Guoli                  | 6,000                                 | -                    | -    | Local                           | Li <sub>2</sub> CO <sub>3</sub>                                    |
|                                       | Huamen                 | 6,000                                 | -                    | -    | Local                           | Li <sub>2</sub> CO <sub>3</sub>                                    |
| RongJie (Youngy)                      | Meishan                | 3,000                                 | -                    | -    | Local                           | Li <sub>2</sub> CO <sub>3</sub>                                    |
| <b>Total</b>                          |                        | <b>132,000</b>                        | <b>176,900</b>       |      |                                 |  |

- Reported spodumene conversion capacity at end-2017 totalled ~132,000tpy LCE
- Output by mineral conversion plants in 2017 was 93,000t LCE, but 27,000t LCE was upgrading/hydroxide conversion
- Capacity utilisation <50% in 2017, historically ~70-75%; **effective capacity therefore ~95,000tpy LCE**
- Expansions to > double capacity, potential of **additional 130,000tpy LCE effective capacity?**

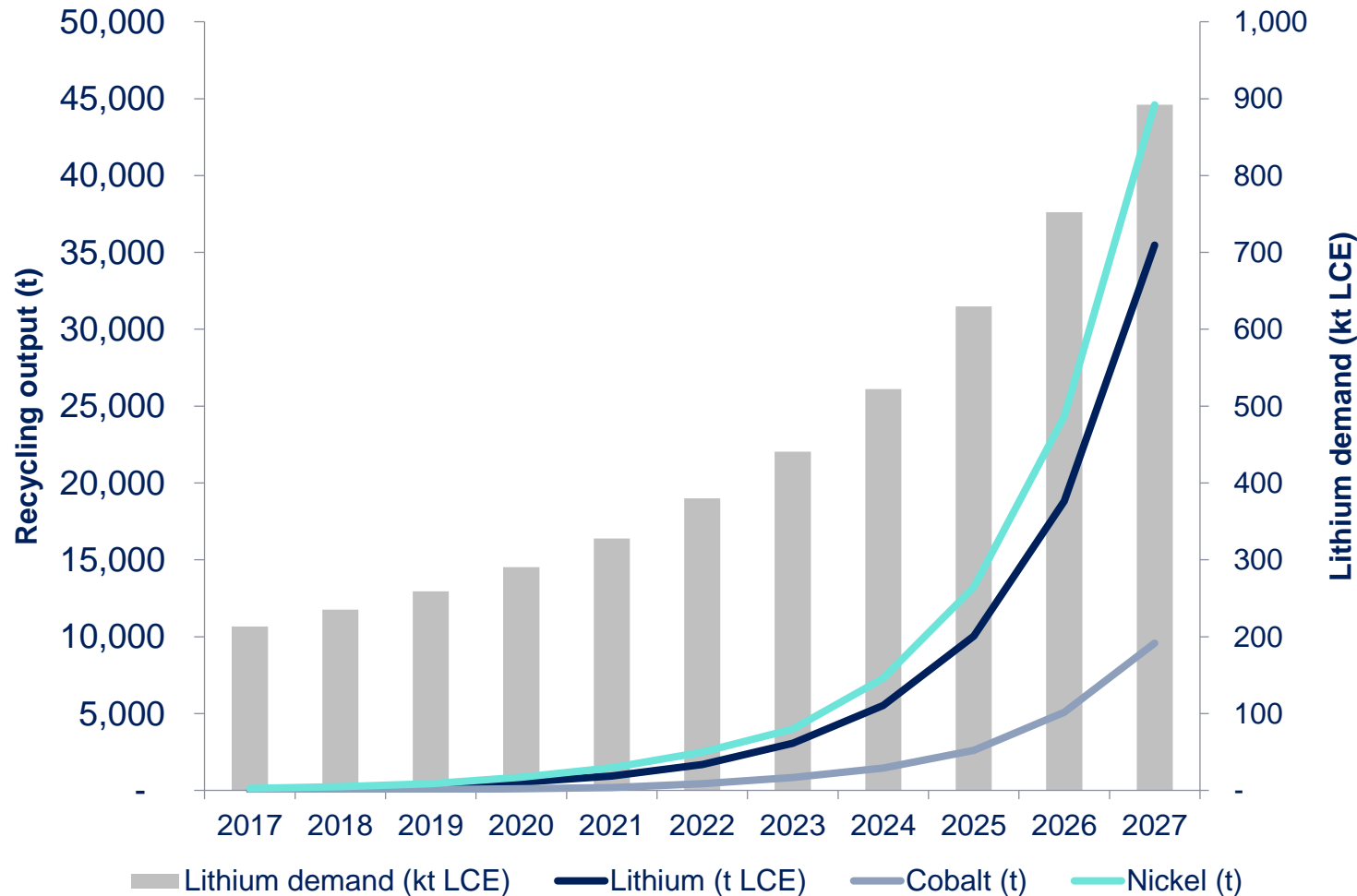


# New spod. converters are popping up or are planned, but few will influence the market in 2018

| New mineral conversion plants |            |                                       |                      |      |                            |  |
|-------------------------------|------------|---------------------------------------|----------------------|------|----------------------------|--|
| Company                       | Plants     | Nameplate capacity end-2017 (tpy LCE) | Expansions (tpy LCE) | Due  | Feedstock source           | Product                                |
| Hebei Tianyuan (Optimum Nano) | Tianyuan   | -                                     | 15,520               | 2018 | Altura (Pilgangoora)       | Li <sub>2</sub> CO <sub>3</sub> / LiOH |
| Jiangxi SE (JV with Burwill)  | Jiangxi    | -                                     | 24,440               | 2018 | Tawana/AMA (Bald Hill)     | Li <sub>2</sub> CO <sub>3</sub> / LiOH |
| Sichuan Zhiyuan               | Hanwang    | -                                     | 14,440               | 2018 | Pilbara DSO (Pilgangoora)  | Li <sub>2</sub> CO <sub>3</sub> / LiOH |
| Greatpower-Jinchuan           | Zhenjiang  | -                                     | 10,000               | 2018 | TBC                        | Li <sub>2</sub> CO <sub>3</sub>        |
| Jiangxi Dongpeng              | Xinyu      | -                                     | 6,000                | 2018 | Prospect (Zimbabwe)        | Li <sub>2</sub> CO <sub>3</sub>        |
| Fancy Resources               | Guangdong  | -                                     | 10,000               | 2018 | Jourdan, Pilbara, Talison? | Li <sub>2</sub> CO <sub>3</sub>        |
| NAL                           | Val d'Or   | C&M                                   | 19,300               | 2018 | Captive                    | Li <sub>2</sub> CO <sub>3</sub>        |
| Lithium Korea                 | TBC        | -                                     | 30,000               | TBC  | Pilbara                    | Li <sub>2</sub> CO <sub>3</sub> / LiOH |
| Nemaska                       | Shawinigan | Pilot                                 | 33,000               | 2021 | Whabouchi                  | LiOH / Li <sub>2</sub> CO <sub>3</sub> |
| <b>Total</b>                  |            | -                                     | <b>143,400</b>       |      |                            |  |

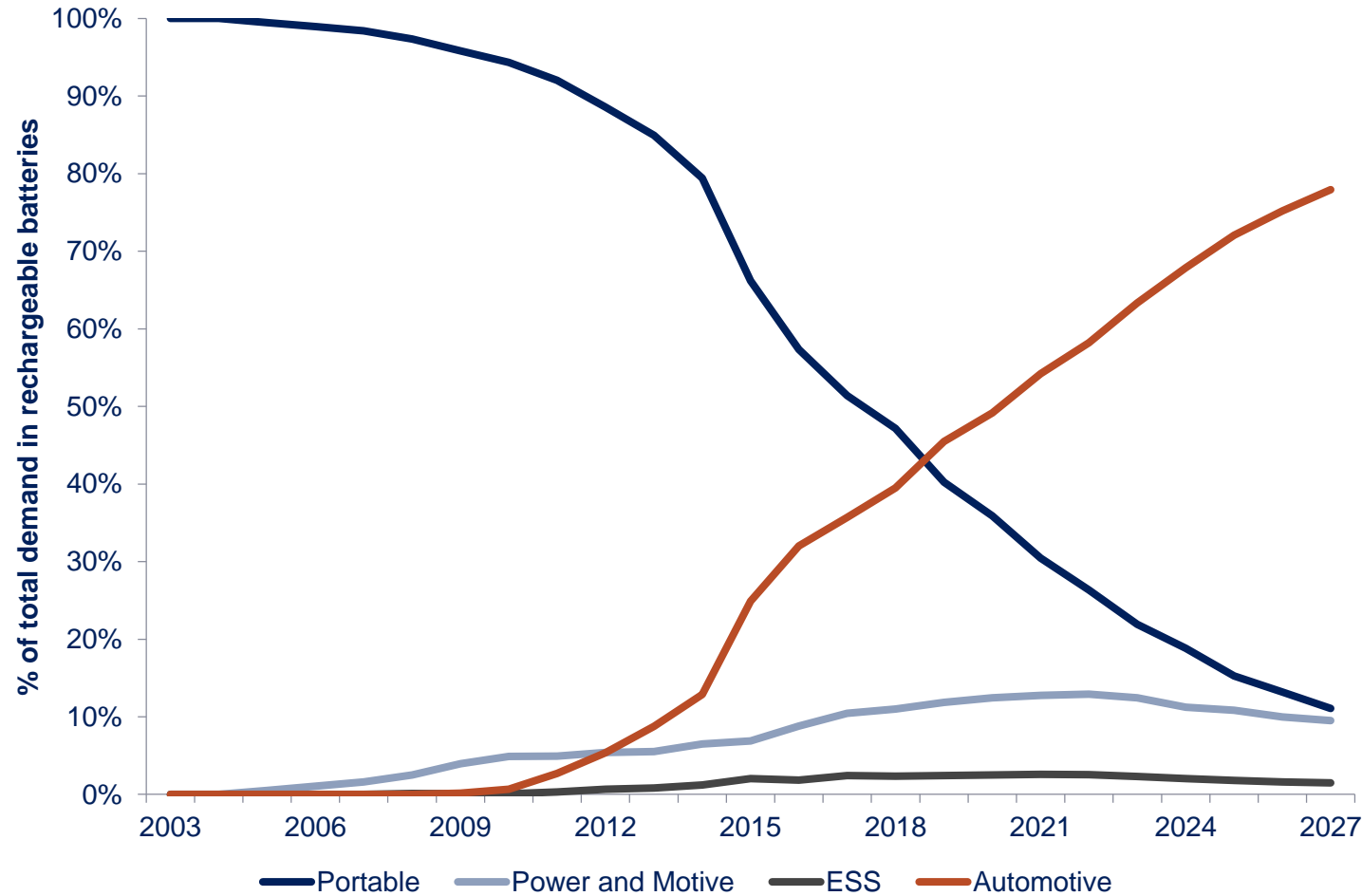
- New plants in China with 80,400tpy LCE capacity are under construction and due to open in 2018
- NAL were recommissioning Val d'Or but the parent company has gone bankrupt and they'll now just sell spod. conc.
- Nemaska are at the financing stage for Whabouchi/ Shawinigan and could open 2021; Lithium Korea plans 30,000tpy.
- Several Chinese plants are linked to Australian producers or potential new projects
- No projects are >50% complete, suggesting 2018 impact will be limited

# Secondary supply to become increasingly important, though will take time to grow



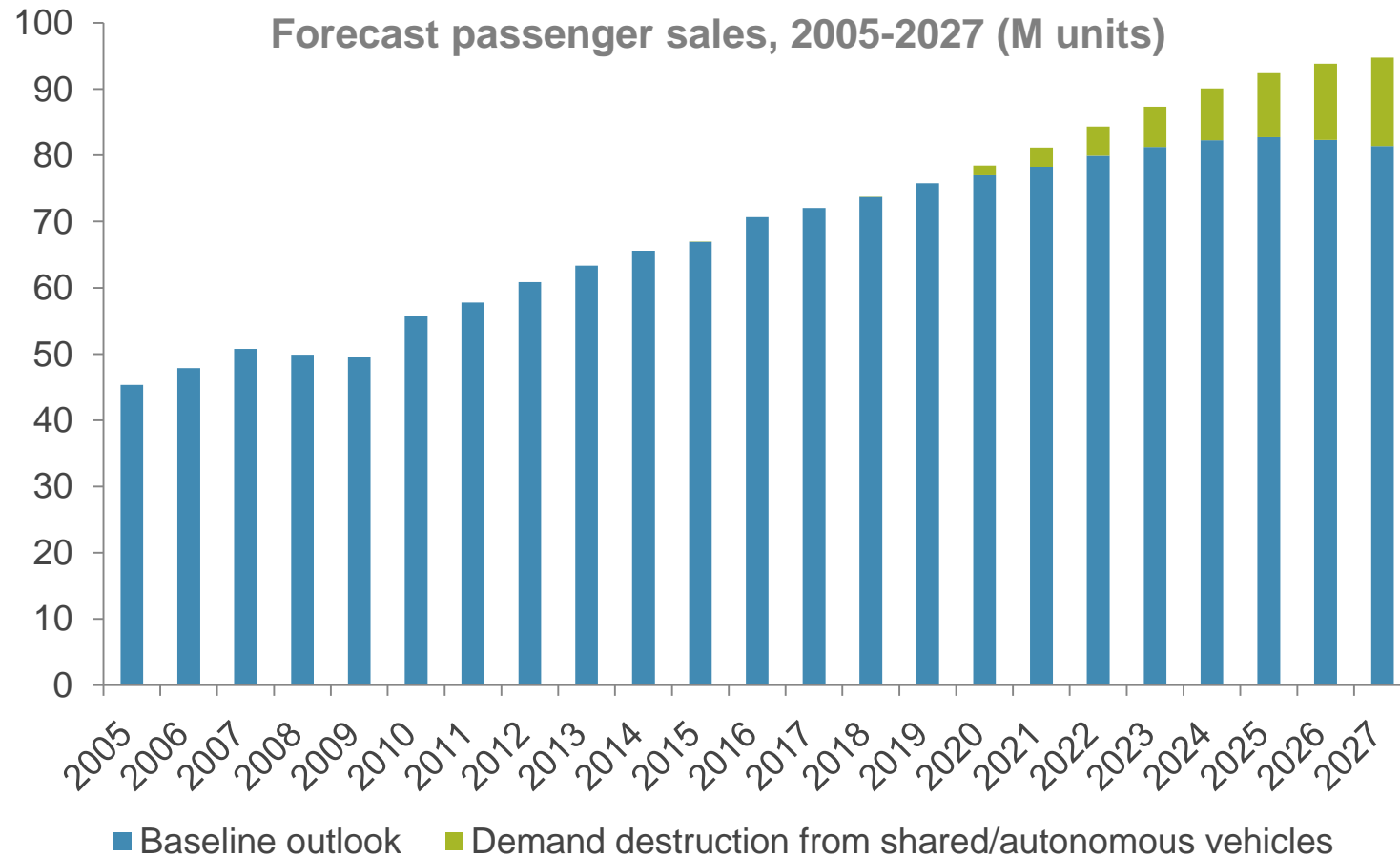
- Recycling needs to overcome a number of hurdles before making an impact
  - Material collection
  - Cost of processing
  - Material value
  - Targeted processing (cobalt, nickel, lithium, etc.)
  - Reuse of batteries
- Investment in recycling becoming more common
  - Umicore
  - Li-Cycle
  - BYD
  - Sumitomo-Nissan-4R
  - JX Nippon

# Can potential bottlenecks be eased from the demand side?



- Changes in cathode chemistries unlikely to have impact on lithium consumption by weight
- Battery technology unlikely to change away from Li-ion in automotive applications
- Smaller battery size possible, though competitive EV market promotes better range/power
- Better motor efficiency?
- Lower EV sales, production targets by manufacturers fail to be met

# Changing consumer/purchasing habits could impact vehicle sales and lithium demand



- Increasingly efficient use of the vehicle fleet may lower demand for personal vehicles
- Ride sharing apps and technology (Uber, BMW's DriveNow, Daimler's Car2Go)
- Autonomous/Semi-autonomous driving still in its infancy
- Has potential to significantly impact vehicles intensity of use in urban areas

# In conclusion...

- Demand growth will be great and place significant strain on lithium supply chain
- Investment to date has focused on mine capacity and battery cells production, greater investment in addition capacity for battery grade materials and battery components (cathode material) needed
- Recycling will become increasingly important and may reduce strain on primary supply, though hindered by available feedstock and cost
- Li-ion technologies are unlikely to be substituted in highest growth areas (Automotive) and there is little scope to reduce lithium intensity of use in batteries
- Sales volumes for EVs / HEVs and ICEs could be impacted by self/shared driving vehicles towards end of forecast period

Roskill on the road...



# Battery Raw Materials 2018

24-25 May 2018  
InterContinental Grand Stanford, Hong Kong

On the road...

# Breakfast at the Tower

9 October 2018  
Kings Great Hall, White Tower, Tower of London

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